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Risk Attitude and Risk Controllability: Their Implications on the Subjective Quantification of Risk in International Construction Projects

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Abstract**—** *The Probability-Impact (P-I) risk matrix is one of the frequently used techniques among the qualitative risk assessment methods in construction projects, which usually utilizes a 1 to 5 rating scale in order to quantify risk. Decision-makers usually apply their personal judgement, experience, and intuition for the quantification of the intensity of a probable risk event in the first stages of analyzing risks. However, the fluctuation observed by many researchers in the risk rating scales that differs from one individual to another is a substantial drawback of the qualitative risk assessment process where some driven factors may have influence the ratings. Hence, in this research the effects of two factors such as decision-makers' attitudes towards a potential risk event and their assumptions about its controllability during the qualitative risk assessment process in international construction projects are studied through a questionnaire survey. In this survey, 74 professionals and 7 academics from the Turkish construction industry have participated. Two hypotheses are tested for their validity, confirming that risk attitude and assumption about risk controllability are the two critical factors that may have influence on the the risk ratings of the individual decision-makers.*

Keywords**— *Decision-Making under risk and uncertainty, Qualitative risk assessment, Risk analysis, Risk attitude, Risk controllability.***

I. INTRODUCTION

Risk management in construction projects is not a strange process anymore. Still, construction companies are subjected to major losses as a result of insufficient risk management [1]. In this process, risk assessment is one of the critical steps, which should be undertaken carefully in order to manage uncertain situations [2]. However, it is impossible to eliminate a risk, but should be mitigated and managed [3]. Therefore, different techniques and methods are introduced in literature in the last few decades for the assessment of risk that fall into a qualitative, quantitative or even semi-quantitative method as per Ebrahimnejad et al. [4]. However, qualitative risk assessment is still dominant in construction projects in comparison to the quantitative one [5; 6; 7; 8; 9; 10; 11; 12; and 1]. Moreover, Mead [13] found out that during the risk assessment process of construction projects, qualitative approaches are generally used. Also, complicated risk assessment techniques are not being used in practice frequently due to two reasons such as lack of knowledge about the situation where a specific technique could be utilized, and limitations of the existing resources like risk assessment experts, time, money, and the necessary technology [15]. The reason for its dominance is the application of intuition, professional judgment, and personal experience of decision-makers [10; 12; 6; 9; 1; and 12]. Further, Li et al. [1] argue that risk assessment in construction projects is usually carried out using subjective manner due to the unique nature of construction projects and data deficiency. Among the qualitative risk assessment methods, the Probability-Impact (P-I) risk matrix is largely used in the construction industry due to its ease [12].

Being simple and handy, there are still problems and complications with the utilization of the qualitative risk assessment to be addressed, especially with the widely used risk tool often called as a Probability-Impact (P-I) risk model or matrix. Indeed, Cox [16] also believe the weaknesses and techno-mathematical problems that exist in the risk matrices. The critical point in this method is when decision-makers assign ratings to risk factors. Cox [16] further suggests the urgency for investigations to be conducted in order to consider the utilization of risk matrices under different situations to see where they can be helpful and where harmful. Some researchers have examined the factors that might affect the risk ratings in risk assessment such as Dikmen and Birgonul [17]; Dikmen et al. [18]; Aven et al. [3]; and Keizer et al. [19]. These authors have used the words such as 'controllability', 'manageability', or 'influence' being the factors that may affect the risk ratings. Moreover, 'risk attitude' is another factor that may affect the risk ratings according to Dikmen et al. [20]; Akintoye and MacLeod [6]; Cox [16]; and Ball and Watt [21]. Thus, the gap that exist in order to investigate the effects of both 'risk attitude' and 'risk controllability' of decision-makers together on risk rating scale is filled here in this study.

This research investigates a particular matter that why risk rating scales have inconsistencies from one decision-maker to another, and to observe the effects of the two latent factors named as 'risk attitude' and 'risk controllability' on decision-makers' judgment while assigning the ratings. Two hypotheses are tested for their validity throughout a questionnaire survey, where 81 individuals from the Turkish construction industry (most of them involved in international construction) have participated in the survey. The response to the survey comprised of 51 contractors, 12 consultants, 7 clients, 7 graduate students from the construction engineering and management filed, and 4 from the other fields of the construction industry that represented a 40% of response rate of the questionnaire. Based on the experience of the participants in the construction field, 23 of them had more than 15 years of experience, 13 had experience between 11 and 15 years, 28 of them between 5 and 10 years, and 17 had less than 5 years of experience. Moreover, 12 of the respondents had high level experience in the risk management field, 38 of them had medium, and 31 of them had a low level risk management experience.

II. QUALITATIVE AND SEMI-QUANTITATIVE RISK ASSESSMENT

While conducting risk assessment, the risk intensity is derived from probability of occurrence of a risk event multiplied by its severity [22; 23; 16; 24; 25; 26; and 27]. Since the qualitative risk assessment represents linguistic terms, we need probability and impact be indicated in a numerical term in order that a risk level can be calculated. Zhi [22] has defined a numerical term between 0 and 1 that could be used for both the probability of occurrence of a risky event and its impact on the project objectives. Tah and Carr [28] have used a Fuzzy Associative Memories (FAMs) applying subjectivity for calculation of the risk magnitude (Risk Likelihood multiplied by Risk Severity) using linguistic terms such as very low, low, medium, high, and very high representing a 1 to 5 scaling. Hastak and Shaked [29] utilized the Analytical Hierarchy Process (AHP) for international construction project risk assessment with adoption of the Probability-Impact risk matrix. The risks were subjectively assessed using a predetermined scale of 0-100, where 0 meant no risk and 100 meant maximum risk. However, the risk Probability-Impact (P-I) matrices that represent 1-5 risk rating system or linguistic terms such as very low, low, medium, high, and very high are adopted or discussed by some researchers such as Cox [16]; El-Sayegh [30]; Abdelgawad and Fayek [31]; Baccarini and Archer [32]; Chapman [33]; and Hanna et al. [34] in construction industry and in the risk analysis field, which generally uses subjective judgment of experts. In the existing literature, there are some other qualitative risk assessment methods, which rely on the intuition, experience, and subjective judgment of the experts. Some of the techniques used for qualitative and semi-quantitative risk assessment in the literature are briefly summarized in Table 1.

In one of the studies carried out by Taroun [12], which is almost a complete literature review on the construction risk modeling and assessment, it demonstrates that the Probability-Impact (P-I) risk model is a popular method by which risk is usually assessed through assessment of probability of occurrence and its impact. That is why, most of the times subjective data and expert judgments are used for risk analysis in construction projects due to the lack of available data and limitations on the practical usage of formal risk analysis process. Risk analysis and management depend centrally on experience, judgment, and intuition in the construction [6; 7; 12; 10; 5; 8; and 9]. Likewise, Dikmen et al. [14] explored that experience, and personal judgment are the two main tools in qualitative risk assessment process. Among the researchers mentioned above, Akintoye and MacLeod [6] in the UK, Shen [4] in China, Wood and Ellis [9] in the UK, Raz and Michael [7] in Israel, and Lyons and Skitmore [10] in the Queensland; they all found that complex tools were not being used extensively for the risk assessment process as most of the risk assessment tools were based on expert judgment, intuition, and experience of the practitioners that has a similarity with the Cox's [16] argument, which emphasizes on the importance of risk attitude and subjective judgment while rating risks during the risk assessment process.

The P-I risk rating model is usually developed by decision-makers' subjective judgment where ratings are assigned to the probability of a risk event occurrence and its impact on the project objectives. Usually, a Likert scale (1 – 5) is used for P-I risk table development in the literature. Due to the heavy reliance of this technique on the subjective judgment of individuals, it is important to know that what factors may affect their judgment when assigning ratings to risks. Focusing on risk attitude as an influential factor on the ratings, Dikmen et al. [20] admit the role of risk attitude as one of the important factors on the risk ratings and quantification. Akintoye and MacLeod [6] assert that individual attitude, belief, feeling, and judgment have influence on risk perception in general. Moreover, Ruan et al. [35] report the defect that decision-makers' risk attitudes are not being taken into account while preparing risk matrices, which represent the importance of risk attitude in decision-making

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process. Besides, Kim and Reinschmidt [36] studied the effects of contractors' risk attitude on competition in construction where they found risk attitude as one of the critical and influential elements.

Dikmen and Birgonul [17] described 'controllability' as a latent factor, which is not being used in the formulas of the risk quantification. Later, Dikmen et al. [18] pointed out the same issue and stated that in general, decision-makers count an implied factor while assigning the risk ratings called 'controllability', which is not considered in the formulas for risk quantification, but its effect is generally taken into account under impact and probability ratings. They believe that if a firm is able to reasonably control a risk factor, then a lower risk rating might be assigned, which means that the experience of a company will have a considerable influence that can mitigate the level of risk in the projects. Keizera et al. [19] also described the project risk character not to be determined by its likelihood and effect only, but by a firm's ability to influence the risk factors as well. Aven et al. [3] raised some issues related to the risk 'manageability' concept but different from that of Dikmen et al. [18], where they expressed that some risks are more manageable than others, which means that the possibility of effects reduction for some risks may be larger in comparison to the other risks. They also argued that a higher risk with a higher manageability would provide a considerable opportunity than the risk with a medium level and low manageability, but no specific methodology was provided to show the importance of manageability in the risk assessment process while assigning the risk ratings.

Table 1. List of Tools/Methods used for Qualitative and Semi-Quantitative Risk Assessment based on the Subjective Judgment After Year 2000

Tool/Method Name	Author(s)	Publication Year	Brief Explanation
AHP	Hastak and Shaked	2000	In the ICRAM-1 model, the hierarchy of risk indicators is systematically evaluated through matrix calculations for preference order determination of a decision maker from the various existing criteria.
FST	Tah and Carr	2001	HRBS model is used. For risk assessment, the likelihood, severity and timing values are determined using qualitative measures such as low, medium and high.
PI Grid	Chapman	2001	Probability-Impact matrix scoring using subjective judgment is involved in this method.
PRR	Baccarini and Archer	2001	Project Risk Rating, where the likelihood and consequence of risks that affect the project cost, quality, and time are rated qualitatively using a matrix.
P-I Matrix, Subjective Judgment	Wood and Ellis	2003	Subjective judgment in RM practice based on experience.
Judgment, Intuition, and Experience	Lyons and Skitmore	2004	Survey results of individuals' perceived risk tolerances involved in senior management in the Queensland engineering construction industry, which shows frequent use of qualitative risk assessment.
P-I & Questionnaire	Fang et al.	2004	In this method, a questionnaire is used to collect the data from respondents who are qualitatively assigning the risk ratings based on risk occurrence probability and influence.
AHP	Dikmen and Birgonul	2006	AHP as a MCDM technique is used for risk and opportunity assessment in the international projects as well their rankings.
FST & Influence Diagramming	Dikmen et al.	2007	This is an influence diagramming method combined with fuzzy risk assessment approach to estimate cost overrun using risk ratings.
FST & AHP	Zeng et al.	2007	This model can handle the expert judgment; also, risks can be evaluated directly using linguistic terms.
P-I Matrix & Questionnaire	El-Sayegh	2008	Based on the survey results, the relative importance index (RII) is calculated based on probability-impact rating for each risk in this method.
P-I and use of MS Access as a Database	Dikmen et al.	2008	This is a post-project risk assessment tool where the risk assessment step is done using probability-impact risk rating with expert judgment.
AHP & Questionnaire	Zayed et al.	2008	A risk index (R) model is proposed in order to assess the effect of sources of risk and uncertainty on a construction project. The weight of risks is calculated with the use of AHP. Also, questionnaires are used to collect the data from experts who have used subjective judgment for the weights of risks.
Fuzzy FMEA & Fuzzy AHP	Abdelgawad and Fayek	2010	This method is applied in a case study using probability, impact, detection/control, and the level of criticality of risk event with the help of linguistic term usage.
Risk Rating	Hanna et al.	2013	In this method, the relative impact (RI), likelihood of risk realization (LORR), risk rating, and the input of recommendations and notification of a 1-5 scale is involved with the application of subjective judgment.

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III. RISK ATTITUDE

Hillson and Murray-Webster [37] define risk attitude as ‘‘a chosen state of mind with regard to those uncertainties that could have a positive or negative effect on objectives.’’ They also insist that attitude only exist in relation to a datum point, which shows that attitude of same individuals changes with the change of circumstances in which they make a decision. Also, it depends on the decision maker's attitude whether to take risk or not. The ISO Guide [38] in their risk management vocabulary defines risk attitude of an organization as ‘‘organization's approach to assess and eventually pursue, retain, take or turn away from risk.’’. Risk attitude can be measured and assessed by expected utility function or via psychometric approaches such as questionnaires and scales [39 and 40]. In the expected utility framework, choices over lotteries are used to represent the attitudes to risk, shown by a probability distribution, and the utility curvature function will imitate these attitudes. On the other hand, psychological approaches ask the people directly about their willingness and agreement about some questions on risky situations, which directly measures risk attitudes [40]. Another approach that challenges the expected utility theory and measures risk attitude of individuals is prospect theory proposed by Kahneman and Tversky [41]. Some researchers have used the technique of lottery choices for the risk attitude assessment in the field of both psychology and economy such as Wärneryd [42]; Kahneman and Tversky [41]; Fellner and Maciejovsky [40]; Pennings and Smidts [49]; Dohmen et al. [43]; Donkers et al. [44]; Kachelmeier and Shehata [45]; Cardenas and Carpenter [46]; and Ye and Wang [47]. Furthermore, some others have used the method of gamble choices to measure attitudes toward risk in various fields like Eckel and Grossman [48]; Binswanger [49]; and Balaz and Williams [50].

Considering risk attitude in the construction Raftery et al. [51] investigated professionals' risk attitudes vigorousness toward monetary risks via interviews before and after a business cycle variation where they found that decisions will vary in response to three stimuli such as framing of decisions, the amount of money involved, and economical condition background. Au and Chan [52] studied the risk attitudes of contract parties to see that how contractors request for payments, and how employers are willing to make payments for the time delay risk due to weather in a construction project. Wang and Yuan [53] identified the important factors that affect risk attitudes of contractors in the Chinese construction industry so that to improve the Risk Based Decision-Making (RBDM). From the 26 factors that were identified, three of them were determined to be of great importance such as: engineering experience, consequences of decision-making, and completeness of project information. For this reason, they developed an evolutionary simulation model to investigate that how risk attitudes will have effect on the success of contractors and the market. Moreover, Bossuyt et al. [54] explored risk attitudes through utility theory in risk-based design so as to address the important risks via numerically based approach rather than the gut feeling usage, and to explain risk-based decisions.

IV. SHORTCOMINGS OF P-I RISK MATRIX

There are still some shortcomings with the utilization of risk matrices to be addressed. Cox [16] claims about the logical and mathematical drawbacks of the risk matrices, which are considered as the bases of information for risk management decision making. In his study, which is titled ‘‘What's wrong with risk matrices?’’, Cox identifies some rational and mathematical limitations of the risk matrices performance such as suboptimal resource allocation, errors, ambiguous inputs and outputs, and poor resolution. He further agrees with the widespread and uncomplicated utilization of risk matrices in the risk management decisions, but strongly recommends a research to be conducted for its better understanding in order to provide some specific indications that in which situations these risk matrices can help and in which situations cannot. Later, Ball and Watt [21] examined the utility and reliability of the risk matrices in the context of public leisure activities and travel where they found that: ‘‘(1) Different risk assessors may assign vastly different ratings to the same hazard. (2) Even following lengthy reflection and learning scatter remains high. (3) The underlying drivers of disparate rating relate to fundamentally different worldviews, beliefs, and a panoply of psychosocial factors that are seldom explicitly acknowledged.’’ Actually in this study, which was a two-stage survey, international postgraduate and undergraduate students those studying either occupational health and safety or risk management had participated. A risk matrix used in this study was a product of (1-5) scaling method where the (1-5) scores were assigned to the individual likelihood and consequence ratings, then the respondents were asked to assign the risk ratings accordingly. At the first stage of the survey, 50 students participated, and then in the second stage of the survey, 21 students representing a subset of the first 50 students participated. The important findings of Ball and Watt's research were that they prepared a table of factors affecting the risk ratings. The risk attitude and lack of specific knowledge were the two factors out of the 15 that can have effect on the risk ratings and which can be connected to this study. Further, Ruan et al. [35] also claimed about the limitation of risk matrix establishment.

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They proposed an approach that integrates risk attitudes based on utility theory with the risk matrix so that to explain how risk attitudes of decision-makers affect the matrix during the risk assessment.

V. RESEARCH METHODOLOGY

The objective of this research is to study the variances in risk ratings that decision-makers assign to risks during qualitative risk assessment process with respect to their attitudes toward risk. As well as the assumptions on risk controllability, which may affect these ratings too. Therefore, a questionnaire survey was administered where 81 individuals from Turkey (most of them working in international construction projects) participated in this survey. The survey data was then analyzed in order to acquire the research objectives and to test the validity of the hypotheses below:

H1: Risk ratings vary with respect to the risk attitudes of decision-makers during the risk assessment process.
H2: Assumptions about risk controllability also affect the risk ratings in addition to the risk attitudes of decision-makers.

The questionnaire was formed of three general parts. In Part 1, general information about respondents are asked, which are composed of four questions such as respondents' current position/title in a firm/company where they work, organization type, experience in the construction industry, and finally their experience in the risk management field. In Part 2, there is a question about respondents' controllability level on a risk factor followed by four risk rating scenarios, where a ready-made risk checklist containing nineteen (19) risk factors is utilized for all four risk scenarios and the risk controllability level. The risk checklist is borrowed from the research paper of Dikmen et al. [18] with their permission as shown in Table 2. The aim for the risk controllability ratings in Part 2 is to find out that how a decision-maker assumes the controllability level for a risk factor. Also, to see that how controllability affects the risk ratings with respect to magnitude of the risk in different risk scenarios, or how the assumptions about controllability change according to the magnitude or level of risk during risk assessment process in international construction projects. The respondents are then asked to assign the risk ratings for the four different risk scenarios after they assign ratings to the risk controllability section. The four risk scenarios are designed based on the project and country risk level, where the first scenario is formed as a case of a project with high complexity (high risk) in a high risky country, the second scenario is formed as a case of a project with low complexity (low risk) in a high risky country, the third scenario is formed as a case of a project with high complexity (high risk) in a low risky country, and the fourth scenario is formed as a case of a project with low complexity (low risk) in a low risky country. This is also important to mention that all four risk scenarios are arranged to represent an international project case. In addition to above risk scenarios design, respondents are asked to evaluate the risk level of a project in each scenario depending on their own perception toward that specific case, rating the case as low, medium, or high level of risk. The risk controllability ratings are considered to range between 1 and 3 rating scale, and the four risk scenario ratings are considered to range between 1 and 5 ratings scale. The legends for the risk ratings and risk controllability ratings are explained to the respondents in order to help them for selecting their choices from the existing legends and assign the risk ratings accordingly, using their subjective judgment. After all the risk ratings are assigned in Part 2 of the questionnaire, the Mean, Standard Deviation (SD), and Coefficient Of Variation (COV) of each risk in each risk scenario will be calculated. The risk factors with highest or lowest Mean ratings, SD, and COV in each risk scenario will be considered for some further analyses and comparisons. These comparisons will then help us to discuss some important points about respondents' attitudes toward risk and their assumptions about risk controllability. Some cases and evidences will be acquired to show the importance of risk attitude and risk controllability as two important factors that may affect the risk ratings. Some statistical correlations will be then tested among the risk attitude, risk controllability, and the four risk scenarios, which will be used for the validation of research hypotheses. Figure 1 represents explanation on risk scenarios and provides information on how and what ratings respondents should assign to risk factors and controllability asked in the questionnaire.

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Table 2. Risk Factors Checklist Borrowed from Dikmen et al. [18]

No.	Risk Factors
1	Poor international relations
2	Instability of political condition
3	Poor attitude towards foreign companies
4	Poor macroeconomic conditions
5	Immaturity of legal system
6	Societal conflict
7	Cultural/Religious differences
8	Vagueness of construction techniques/methods
9	Complexity (technical and managerial)
10	Unavailability of resources
11	Poor planning
12	Vagueness of scope
13	Design errors
14	Unavailability of funds
15	Delay in payments
16	Attitude of client
17	Inexperience of client
18	Unavailability of subcontractors
19	Poor performance of subcontractors

Risk Scenarios	Project Risk Level (Complexity)	Country Risk Level
First Risk Scenario	High	High
Second Risk Scenario	Low	High
Third Risk Scenario	High	Low
Fourth Risk Scenario	Low	Low

Fig 1 (a)

Intensity of Risk	Rating Scale
Very Low Impact	1
Low Impact	2
Medium Impact	3
High Impact	4
Very High Impact	5

Fig 1 (b)

Risk Controllability Level	Rating Scale
Fully Uncontrollable	1
Partially Controllable	2
Fully Controllable	3

Fig 1 (c)

Fig. 1: Explanation for Project and Country Risk Levels, and Rating Legends for Risk Factors and Risk Controllability

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In the last part of the questionnaire, which is Part 3, a risk attitude measurement scenario is put in place so that to capture respondents' attitudes toward risk whether they have risk averse, risk neutral, or risk seeking attitudes. In this section of the questionnaire, a very simple example of a coin flipping game is offered to respondents in order that everyone can understand it easily, and to provide correct answers based on the attitudes they have toward risk. In this game, a coin will be flipped, if the coin comes heads, the participant will get $100, and if the coin comes tails, the participant will get $0 means nothing. The important point here is to mention that this coin flipping game is just for once and it is not a continuous game, the game will be stopped after one flip. What respondents are asked is to choose the minimum certain amount of money they would accept to leave the game for from the give options in the questionnaire. The Expected Monetary Value (EMV) for this game is $50, as EMV = 100 x 0.50 + 0 x 0.50 = 50. Therefore, it is aimed that if a respondent selects $50, he or she has a risk neutral attitude, if selects less than $50, a risk averse attitude, and if selects more than $50, will has risk seeking attitude. This is very important to state that the questionnaire was prepared and designed in a very simple and attractive way in order that every respondent can understand and can answer each question easily.

5.1. Questionnaire distribution and collection

The questionnaire was sent electronically in E-mail to a total of 202 intended respondents. The target respondents of this questionnaire were the professionals working in the construction industry and the academics as well. One E-mail was sent to 190 practitioners where most of them working in the Turkish construction industry involved in international construction projects, and some other professionals working in International Companies and Organizations inside and outside of Turkey. Another E-mail was sent to 12 graduate students of the Middle East Technical University (METU) who were involved in the construction management and Engineering studies. In return, a total of 81 useable responses were received making a total of 40% response rate of the survey which is an acceptable response rate in E-mailing questionnaire survey as per Moser and Kalton [55]. For more information about the questionnaire, please refer to Hayat [56].

VI. DATA ANALYSIS PROCESS

After receiving the questionnaires, the data was analyzed in order to acquire some basic statistics about respondents such as respondents' organization type, experience in the construction industry, and their experience in the risk management field at the beginning. The statistics about risk levels that respondents had chosen for the four risk scenarios and information about their risk attitudes were also obtained in the first step of the data analysis. In the second stage of the analysis, risk factors in each risk scenario and in the risk controllability sections were ranked with respect to their Mean ratings so that to see their locations in different risk scenarios, compare them with each other, and observe that how the assumptions of decision-makers about risk controllability affect these ratings or these rankings. Observing the effects of decision-makers' risk attitudes on the risk ratings was another task in this step of the analysis as well. Some significant cases are then chosen for the support and validation of the research hypotheses. The third stage of the data analysis is a correlation test among the six variables such as risk attitude, risk controllability level, and the four risk scenarios. Taking into account that all these variables are categorical (ordinal and nominal), a Spearman's Rank Correlation Coefficient or Spearman's rho test was performed to discover the strength of link between the pairs of variables. This is to remind that before performing Spearman's rho test, the relationships were checked through scatter plot diagrams confirming the relationships for further correlation testing. Spearman's rho test is considered as an appropriate analysis for the non-parametric tests and for the strength of association between a pair of random variables according to Schmid and Schmidt [57]. The numerical value for Spearman's rho ranges from +1.0 to -1.0, and in general, correlation coefficient or $r > 0$ represents a positive relationship and $r < 0$ represents a negative relationship between pairs of variables. For Spearman's rho test, the level of significance or alpha was set to 5%, which means that the null hypothesis will be rejected at the p-value smaller than or equal to 0.05 ($p \leq 0.05$). The following statistical formula represents Spearman's rho or Spearman's Rank Correlation Coefficient.

$$r_s = 1 - \frac{6\sum d_i^2}{n(n^2\text{-}1)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

According to Cohen and Cohen [58], the significance of a positive/direct or negative/inverse relationship between two variables is small/weak when the correlation coefficient (r) is between 0.1 and 0.3, moderate/medium when r is between 0.3 and 0.5, and strong when r is between 0.5 and 1. Therefore, this significance is used for the correlation among the variables here in this study.

VII. RESULTS AND DISCUSSIONS

Table 3. Represents some basic data showing the frequencies of the participants' organization types, experience in construction, experience in the risk management field, and finally their risk attitudes

categorized as risk averse, risk neutral and risk seeking. The mean ratings for 1st and 4th risk scenarios are presented in Table 4. Here we can see that risk #14 and #15 from the original checklist are ranked as the highest two factors with respect to mean values. However, the mean ratings for these two factors are 4.19 and 3.96 in the case where a high complex project is located in a high risky country, and 3.17 and 3.02 in a situation of a low complex project located in a low risky country. This noticeable change in the mean rating of 81 respondents from once situation to another shows that their risk attitudes have played a role in decision-making. Besides, the risk #7 from the original list is ranked the lowest in terms of mean ratings in both mentioned scenarios, but with different values. Looking to the overall mean ratings of all the 19 risk factors, the 1st and 2nd scenarios have 3.51 and 2.38 mean values respectively. It is not just about the risk attitude influence; we also argue that the individuals have also taken their experience into account here to utilize how controllable these risk events are. Therefore, is clearly understandable that the risk attitudes and illusion of risk controllability of the respondents change with respect to the magnitude of risk in different risk scenarios. As a result, it can be claimed that decision-makers with a risk averse attitude are usually assigning higher risk ratings in comparison to that of decision-makers with risk neutral and risk seeking attitudes, which represents a perspective on influence of risk attitude in rating scales.

Table 3. Statistics on Respondents' Organization Type, their Experience in the Construction and Risk Management Field, and their Attitudes towards Risk

Org. Type	Frequency	Experience in Construction	Frequency	Experience in Risk Management	Frequency	Risk Attitude	Frequency
Client	7	< 5 years	17	Low/Limited	31	Risk Averse	25
Contractor	51	5 to 10 years	28	Medium	38	Risk Neutral	19
Consultant	12	11 to 15 years	13	High	12	Risk Seeking	37
Academic	7	> 15 years	23				
Other	4						
Total	**81**		**81**		**81**		**81**

Table 4. Comparison of 1st and 4th Risk Scenarios

1st Risk Scenario (High Risky Project-High Risky Country)				4th Risk Scenario (Low Risky Project-Low Risky Country)			
Ranking with Respect to Mean Ratings	**Ranking in the Risk Checklist**	**Risk Factors**	**Mean Ratings**	**Ranking with Respect to Mean Ratings**	**Ranking in the Risk Checklist**	**Risk Factors**	**Mean Ratings**
1	14	Unavailability of funds	4.19	1	14	Unavailability of funds	3.17
2	15	Delay in payments	3.96	2	15	Delay in payments	3.02
3	2	Instability of political condition	3.96	3	11	Poor planning	2.64
4	5	Immaturity of legal system	3.94	4	10	Unavailability of resources	2.63
5	11	Poor planning	3.81	5	12	Vagueness of scope	2.62
6	10	Unavailability of resources	3.72	6	19	Poor performance of subcontractors	2.53
7	19	Poor performance of subcontractors	3.68	7	16	Attitude of client	2.49
8	13	Design errors	3.64	8	13	Design errors	2.48
9	12	Vagueness of scope	3.62	9	5	Immaturity of legal system	2.46
10	4	Poor macroeconomic conditions	3.52	10	18	Unavailability of subcontractors	2.37
11	18	Unavailability of subcontractors	3.47	11	4	Poor macroeconomic conditions	2.27
12	16	Attitude of client	3.44	12	2	Instability of political condition	2.22
13	8	Vagueness of construction techniques/methods	3.40	13	6	Societal conflict	2.21
14	9	Complexity (technical and managerial)	3.38	14	8	Vagueness of construction techniques/methods	2.19
15	1	Poor international relations	3.31	15	9	Complexity (technical and managerial)	2.15
16	3	Poor attitude towards foreign companies	3.20	16	17	Inexperience of client	2.11
17	17	Inexperience of client	3.12	17	3	Poor attitude towards foreign companies	2.04
18	6	Societal conflict	3.10	18	1	Poor international relations	1.84
19	7	Cultural/Religious differences	2.30	19	7	Cultural/Religious differences	1.72
Mean Ratings for the 1st Risk Scenario			**3.51**	**Mean Ratings for the 4th Risk Scenario**			**2.38**

From the results, we present another interesting case in which mean risk ratings in each risk scenario with respect to three categories of risk attitudes of the respondents are summarized, shown in Table 5. Here we can witness that respondents with a risk averse attitude have assigned mean ratings of 3.90, 3.49, 3.13, and 2.72, respondents with a neutral risk attitude have assigned mean ratings of 3.35, 3.01, 2.98, and 2.40, and respondents with a risk seeking attitude have assigned mean ratings of 3.37, 2.86, 2.71, and 2.13 to the 1st, 2nd, 3rd, and 4th risk scenarios respectively. A sharp decrease exists in the mean ratings from a risk averse attitude to risk neutral and risk seeking

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attitude that confirms the relation of risk attitude on decision-makers rating scales.

Table 5. Mean Ratings of the Respondents with Respect to their Risk Attitudes

Explanation	1st Risk Scenario	2nd Risk Scenario	3rd Risk Scenario	4th Risk Scenario	Risk Attitude
Mean Ratings of 25 Respondents	3.9	3.49	3.13	2.72	Risk Averse
Mean Ratings of 19 Respondents	3.35	3.01	2.98	2.4	Risk Neutral
Mean Ratings of 37 Respondents	3.37	2.86	2.71	2.13	Risk Seeking

In addition to these, a critical case explaining the association of controllability with decision-makers' risk rating scales is summarized in Table 6. In this case, mean ratings of all 19 risk factors in four risk scenarios with respect to highest and lowest values are presented so as to validate the second hypothesis of the research. A respondent with the highest mean ratings of 4.32, 3.90, 3.53, and 2.79 for the four risk scenarios is the person who has the lowest controllability with respect to mean ratings of 1.26 among all the respondents. On the other hand, a respondent with the lowest mean ratings of 3.63, 2.79, 2.42, and 1.84 for the four risk scenarios is the person who has the highest controllability with respect to mean ratings of 2.53 among all the respondents. This contrast in thinking of less controllable situation and assigning higher ratings to risk, and thinking of more controllable circumstance and then assigning lower ratings to risk is a clear indicator on how the illusion of risk controllability affects the risk rating scales.

Table 6. Comparison of the Highest and Lowest Mean Ratings for Risk Controllability vs. Mean Ratings of the Four Risk Scenarios

Explanation	Controllability	1st Risk Scenario	2nd Risk Scenario	3rd Risk Scenario	4th Risk Scenario
Mean Ratings (Lowest Controllability, Highest Risk Ratings)	1.26	4.32	3.90	3.53	2.79
Mean Ratings (Highest Controllability, Lowest Risk Ratings)	2.53	3.63	2.79	2.42	1.84

Finally, the correlation test results between risk attitude and risk controllability, risk attitude and four risk scenarios, and risk controllability and four risk scenarios are presented in Tables 7, 8, and 9 respectively. Ratings of 1, 2, and 3 are assigned to controllability on a risk event from fully uncontrollable to partially controllable and fully controllable situation shown in Figure 1. The risk averse, risk neutral, and risk seeking attitudes are then also changed to a numerical form such as 1, 2, and 3 respectively. Then correlation test between these two factors indicate +0.461 significance level that shows a moderate positive relationship in Table 7, which means that a person with a risk seeking attitude may usually tend to be able of controlling a risky event, but when it comes to a risk averse attitude, people may be inclined toward the feeling of not being able to fully control a risky situation. Further, the correlation between risk attitude and four risk scenarios indicate a medium correlation as well except for 3rd risk scenario, which is –0.262, but it is still close to a negative moderate significance. The results from this correlation in Table 8 indicate that a risk averse decision-maker may assign higher ratings to risks than a decision-maker who has risk seeking attitude. In Table 9, the correlation between risk controllability and the four risk scenarios is observed to be a negative moderate relationship. The negative relationship underlines that a person who is judging a risk event to be more controllable may assign lower risk rating scales rather than a person who personally judge a risk event to be not fully controllable if happens. Therefore, all the results discussed above support the two hypotheses of the research.

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Table 7. Correlation Test Results between Risk Controllability and Risk Attitude

Spearman's rho			Assumptions on Risk Controllability Level	Risk Attitude
	Assumptions on Risk Controllability Level	Correlation Coefficient	1.000	0.461**
		Sig. (2-tailed)	.	0.000
		N	81	81
	Risk Attitude	Correlation Coefficient	0.461**	1.000
		Sig. (2-tailed)	0.000	.
		N	81	81

**. Correlation is significant at the 0.01 level (2-tailed)

Table 8. Correlation Test Results Between Risk Attitude and the Four Risk Scenarios

Spearman's rho			1st Risk Scenario	2nd Risk Scenario	3rd Risk Scenario	4th Risk Scenario
	Risk Attitude	Correlation Coefficient	-0.372**	-0.422**	-0.262*	-0.380**
		Sig. (2-tailed)	0.001	0.000	0.018	0.000
		N	81	81	81	81

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

Table 9. Correlation Test Results Between Risk Controllability and the Four Risk Scenarios

Spearman's rho			1st Risk Scenario	2nd Risk Scenario	3rd Risk Scenario	4th Risk Scenario
	Assumptions on Risk Controllability Level	Correlation Coefficient	-0.445**	-0.452**	-0.423**	-0.447**
		Sig. (2-tailed)	0.001	0.000	0	0.000
		N	81	81	81	81

**. Correlation is significant at the 0.01 level (2-tailed)

VIII. CONCLUSION

This research investigated the effects of both ‘‘risk attitude’’ and the illusion of ‘‘risk controllability’’ on the risk ratings using 1 to 5 scaling method while conducting qualitative risk assessment in international construction projects. Two hypotheses are tested and validated through a questionnaire survey, and the major findings of the study are:

- Risk attitude is critical factor that can affect the risk ratings of decision-makers during the risk assessment process.
- Illusion of risk controllability is also an important factor that may affect the risk ratings in addition to risk attitude.
- Risk attitude has a negative moderate correlation with the risk ratings, which means that a risk averse person may assign higher ratings to risks, whereas a risk seeking person may assign lower ratings.
- Risk controllability has a negative moderate correlation with the risk ratings too, as such, the higher the controllability, the lower the risk ratings are or vice-versa.
- Decision-makers always consider a latent but crucial factor into account while assigning the risk ratings during assessment risk, which is controllability.
- Decision-makers are more sensitive to country risk rather than the project risk per se.
- Comparing country and project risks, country risks are less controllable than project risks for decision-makers while using their subjective judgment.
- Although being prevalent and dominant, the P-I risk ratings still have some drawbacks.

This study can be a good reference for those who are willing to pursue a comprehensive research about the effects and factors that can affect the risk ratings while decision-makers assign to risks using 1 to 5 scaling method, conducting qualitative risk assessment in international construction projects. Further researches can focus on more specific risk cases and scenarios for international construction projects conducting a questionnaire survey with a greater sample size than what was performed by this research. In addition to mailing survey, brainstorming session, group interviews, and Delphi method surveys may help further researches to find stronger relationships among the risk ratings, risk attitude, and assumptions about risk controllability. Much detailed cases for risk attitude measurement and illusion of risk controllability may also help further researches.

To conclude, the P-I risk matrices are widely used and easy to utilize while conducting qualitative risk assessment. Nevertheless, they have some serious

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shortcomings in terms of variances in the rating scales from one individual to another. Thus, in this study we have focused on two significant factors such as ‘‘risk attitude’’ and the illusion of ‘‘risk controllability’’ so that to provide some contribution to the improvement of the P-I risk matrices usage, especially in international construction project.

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REFERENCES

[1] Li, N., Fang, D., & Sun, Y. (2015). Cognitive Psychological Approach for Risk Assessment in Construction Projects. *Journal of Management in Engineering*, *32*(2).

[2] Islam, M. S., Nepal, M. P., Skitmore, M., & Attarzadeh, M. (2017). Current research trends and application areas of fuzzy and hybrid methods to the risk assessment of construction projects. *Advanced Engineering Informatics*, *33,* 112-131.

[3] Aven, T., Vinnem, J. E., & Wiencke, H. S. (2007). A decision framework for risk management, with application to the offshore oil and gas industry. *Reliability Engineering & System Safety*, *92*(4), 433-448.

[4] Ebrahimnejad, S., Moosavi, S. M., & Ghorbanikia, A. (2007). Risk identification and assessment in Iran construction supply chain. *Proc. first international risk cong*, 169-186.

[5] Shen, L. Y. (1997). Project risk management in Hong Kong. *International Journal of Project Management*, *15*(2), 101-105.

[6] Akintoye, A. S., & MacLeod, M. J. (1997). Risk analysis and management in construction. *International journal of project management*, *15*(1), 31-38.

[7] Raz, T., & Michael, E. (2001). Use and benefits of tools for project risk management. *International journal of project management*, *19*(1), 9-17.

[8] Patterson, F. D., & Neailey, K. (2002). A risk register database system to aid the management of project risk. *International Journal of Project Management*, *20*(5), 365-374.

[9] Wood, G. D., & Ellis, R. C. (2003). Risk management practices of leading UK cost consultants. *Engineering, Construction and Architectural Management*, *10*(4), 254-262.

[10] Lyons, T., & Skitmore, M. (2004). Project risk management in the Queensland engineering construction industry: a survey. *International journal of project management*, *22*(1), 51-61.

[11] Forbes, D., Smith, S., & Horner, M. (2008). Tools for selecting appropriate risk management techniques in the built environment. *Construction Management and economics*, *26*(11), 1241-1250.

[12] Taroun, A. (2014). Towards a better modelling and assessment of construction risk: Insights from a literature review. *International Journal of Project Management*, *32*(1), 101-115.

[13] Mead, P. (2007). Current trends in risk allocation in construction projects and their implications for industry participants. *Construction Law Journal*, *23*(1), 23.

[14] Dikmen, I., Birgonul, M. T., & Arikan, A. E. (2004, September). A critical review of risk management support tools. In *20th Annual ARCOM Conference* (Vol. 2, pp. 1145-1154). Heriot-Watt University Edinburgh, UK.

[15] Forbes, D., Smith, S., & Horner, M. (2008). Tools for selecting appropriate risk management techniques in the built environment. *Construction Management and economics*, *26*(11), 1241-1250.

[16] Anthony Tony Cox, L. (2008). What's wrong with risk matrices?. *Risk analysis*, *28*(2), 497-512.

[17] Dikmen, I., & Birgonul, M. T. (2006). An analytic hierarchy process based model for risk and opportunity assessment of international construction projects. *Canadian Journal of Civil Engineering*, *33*(1), 58-68.

[18] Dikmen, I., Birgonul, M. T., & Han, S. (2007). Using fuzzy risk assessment to rate cost overrun risk in international construction projects. *International Journal of Project Management*, *25*(5), 494-505.

[19] Keizera, J. A., Halman, J. I., & Song, M. (2002). From experience: applying the risk diagnosing methodology. *Journal of product innovation management*, *19*(3), 213-232.

[20] Dikmen, I., Birgonul, M. T., Anac, C., Tah, J. H. M., & Aouad, G. (2008). Learning from risks: A tool for post-project risk assessment. *Automation in construction*, *18*(1), 42-50.

[21] Ball, D. J., & Watt, J. (2013). Further thoughts on the utility of risk matrices. *Risk analysis*, *33*(11), 2068-2078.

[22] Zhi, H. (1995). Risk management for overseas construction projects. *International journal of project management*, *13*(4), 231-237.

[23] Ward, S. C. (1999). Assessing and managing important risks. *International Journal of Project Management*, *17*(6), 331-336.

[24] KarimiAzari, A., Mousavi, N., Mousavi, S. F., & Hosseini, S. (2011). Risk assessment model selection in construction industry. *Expert Systems with Applications*, *38*(8), 9105-9111.

[25] Bannerman, P. L. (2008). Risk and risk management in software projects: A reassessment. *Journal of Systems and Software*, *81*(12), 2118-2133.

[26] Williams, T. M. (1993). Risk-management infrastructures. *International Journal of Project Management*, *11*(1), 5-10.

[27] Zeng, J., An, M., & Smith, N. J. (2007). Application of a fuzzy based decision making methodology to construction project risk assessment. *International journal of project management*, *25*(6), 589-600.

[28] Tah, J. H. M., & Carr, V. (2001). Knowledge-based approach to construction project risk management. *Journal of computing in civil engineering*, *15*(3), 170-177.

[29] Hastak, M., & Shaked, A. (2000). ICRAM-1: Model for international construction risk assessment. *Journal of Management in Engineering*, *16*(1), 59-69.

[30] El-Sayegh, S. M. (2008). Risk assessment and allocation in the UAE construction industry. *International journal of project management*, *26*(4), 431-438.

[31] Abdelgawad, M., & Fayek, A. R. (2010). Risk management in the construction industry using combined fuzzy FMEA and fuzzy AHP. *Journal of Construction Engineering and Management*, *136*(9), 1028-1036.

[32] Baccarini, D., & Archer, R. (2001). The risk ranking of projects: a methodology. *International Journal of Project Management*, *19*(3), 139-145.

[33] Chapman, R. J. (2001). The controlling influences on effective risk identification and assessment for construction design management. *International Journal of Project Management*, *19*(3), 147-160.

[34] Hanna, A. S., Thomas, G., & Swanson, J. R. (2013). Construction risk identification and allocation: Cooperative approach. *Journal of Construction Engineering and Management*, *139*(9), 1098-1107.

[35] Ruan, X., Yin, Z., & Frangopol, D. M. (2015). Risk matrix integrating risk attitudes based on utility theory. *Risk Analysis*, *35*(8), 1437-1447.

[36] Kim, H. J., & Reinschmidt, K. F. (2010). Effects of contractors' risk attitude on competition in construction. *Journal of Construction Engineering and Management*, *137*(4), 275-283.

[37] Hillson, D., & Murray-Webster, R. (2007). *Understanding and managing risk attitude*. Gower Publishing, Ltd.

[38] ISO Guide 73:2009. (2009). *Risk management—Vocabulary*. Geneva: International Organization for Standardization.

[39] Pennings, J. M., & Smidts, A. (2000). Assessing the construct validity of risk attitude. *Management Science*, *46*(10), 1337-1348.

[40] Fellner, G., & Maciejovsky, B. (2007). Risk attitude and market behavior: Evidence from experimental asset markets. *Journal of Economic Psychology*, *28*(3), 338-350.

[41] Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the econometric society*, 263-291.

[42] Wärneryd, K. E. (1996). Risk attitudes and risky behavior. *Journal of economic psychology*, *17*(6), 749-770.

[43] Dohmen, T., Falk, A., Huffman, D., Sunde, U., Schupp, J., & Wagner, G. G. (2011). Individual risk attitudes: Measurement, determinants, and behavioral consequences. *Journal of the European Economic Association*, *9*(3), 522-550.

[44] Donkers, B., Melenberg, B., & Van Soest, A. (2001). Estimating risk attitudes using lotteries: A large sample approach. *Journal of Risk and uncertainty*, *22*(2), 165-195.

[45] Kachelmeier, S. J., & Shehata, M. (1992). Examining risk preferences under high monetary incentives: Experimental evidence from the People's Republic of China. *The American Economic Review*, 1120-1141.

[46] Cardenas, J. C., & Carpenter, J. (2013). Risk attitudes and economic well-being in Latin America. *Journal of Development Economics*, *103*, 52-61.

[47] Ye, T., & Wang, M. (2013). Exploring risk attitude by a comparative experimental approach and its implication to disaster insurance practice in China. *Journal of Risk Research*, *16*(7), 861-878.

[48] Eckel, C. C., & Grossman, P. J. (2008). Forecasting risk attitudes: An experimental study using actual and forecast gamble choices. *Journal of Economic Behavior & Organization*, *68*(1), 1-17.

[49] Binswanger, H. P. (1980). Attitudes toward risk: Experimental measurement in rural India. *American journal of agricultural economics*, *62*(3), 395-407.

[50] Balaz, V., & Williams, A. M. (2011). Risk attitudes and migration experience. *Journal of Risk research*, *14*(5), 583-596.

[51] Raftery, J., Csete, J., & Hui, S. K. F. (2001). Are risk attitudes robust? Qualitative evidence before and after a business cycle inflection. *Construction Management & Economics*, *19*(2), 155-164.

[52] Au, M. C., & Chan, E. H. (2005). Attitudes of contractors and employers towards transfer of a time-

https://dx.doi.org/10.22161/ijaers.4.10.6 ISSN: 2349-6495(P) | 2456-1908(O)

related risk in construction contracts. In *Construction Research Congress 2005: Broadening Perspectives* (pp. 1-13).

[53] Wang, J., & Yuan, H. (2011). Factors affecting contractors' risk attitudes in construction projects: Case study from China. *International Journal of Project Management*, *29*(2), 209-219.

[54] Van Bossuyt, D., Hoyle, C., Tumer, I. Y., & Dong, A. (2012). Risk attitudes in risk-based design: Considering risk attitude using utility theory in risk-based design. *AI EDAM*, *26*(4), 393-406

[55] Moser, C. A., & Kalton, G. (1972). *Survey methods in social investigation*. 2nd Edition. New York.

[56] Hayat, E. (2014). Factors affecting the risk ratings assigned by decision-makers under uncertain situations: the case of international construction (Master Thesis). Middle East Technical University, Ankara.

[57] Schmid, F., & Schmidt, R. (2007). Multivariate extensions of Spearman's rho and related statistics. *Statistics & Probability Letters*, *77*(4), 407-416.

[58] Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2013). *Applied multiple regression/correlation analysis for the behavioral sciences*. Routledge.